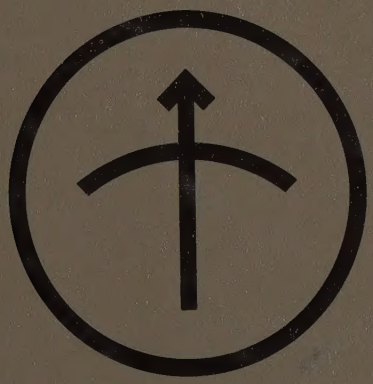
MODEL 179
STANDARD PULSE GENERATOR

Operating INSTRUCTIONS



MEASUREMENTS

A McGRAW-EDISON DIVISION

BOONTON NEW JERSEY

OPERATING INSTRUCTIONS

MODEL 179
STANDARD PULSE GENERATOR

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BOONTON NEW JERSEY

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Additional information with regard to the applications and maintenance of this equipment will be available from time to time. Users of the Model 179 are urged to discuss their problems with us and to suggest such modifications as might make the instrument more adaptable to their special requirements.

Maintenance difficulties should be reported to MEASUREMENTS before proceeding with actual repairs, since, through our familiarity with the instrument, we are able to suggest the appropriate repair procedure.

Engineering Department

MEASUREMENTS
A McGraw-Edison Division

Boonton, New Jersey

U. S. A.

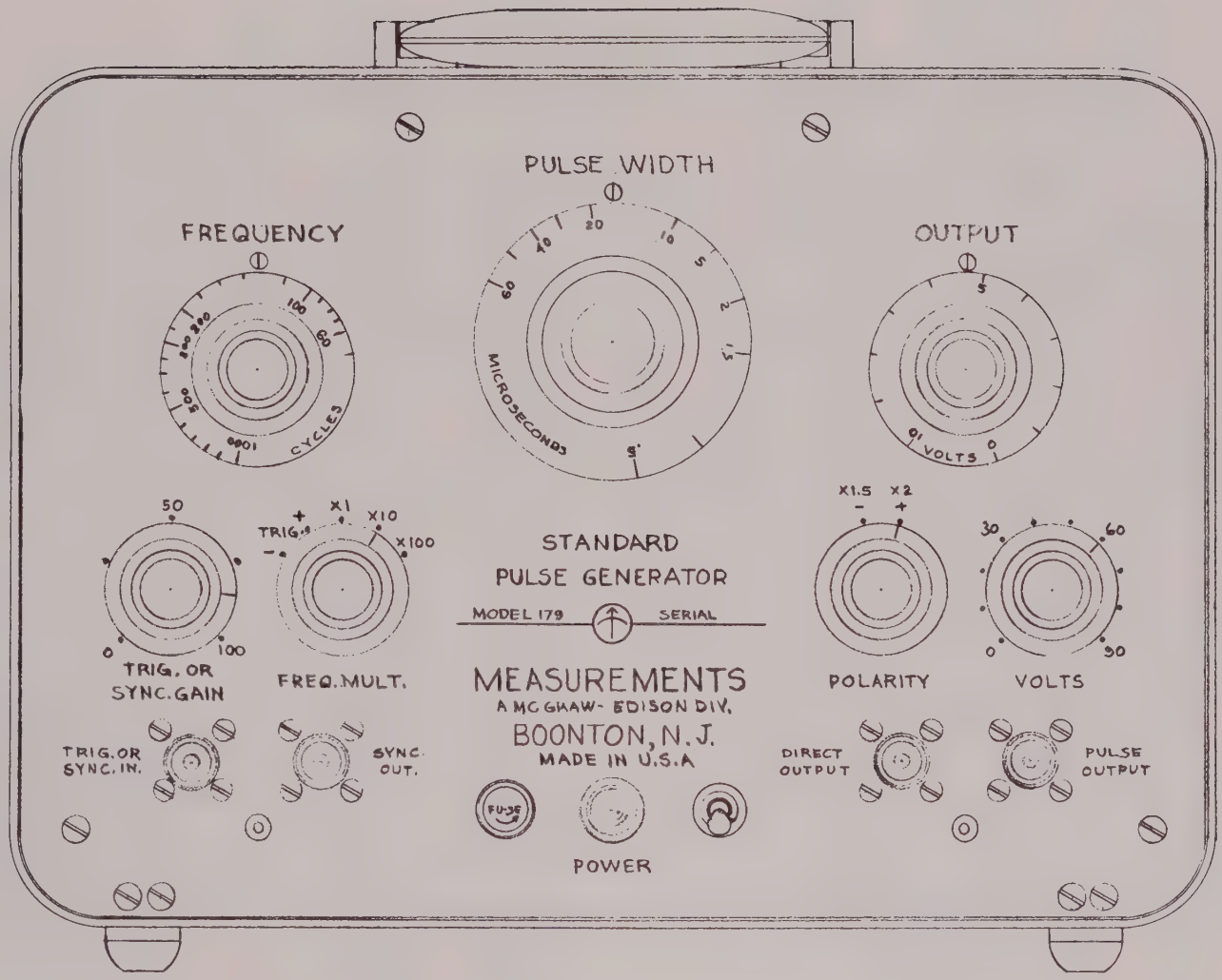

Figure 1. Front View of Model 179 Standard Pulse Generator.

CHAPTER 1

INTRODUCTION

SECTION I.

GENERAL

1. SCOPE OF MANUAL

a. This manual describes the basic operation, application, construction and maintenance of the Model 179 Standard Pulse Generator. Two appendices follow the text of the manual. Appendix I describes recommended procedure for preparing the instrument for prolonged storage or re-shipment. Appendix II contains a Table of Replaceable Parts.

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SECTION II.

DESCRIPTION AND DATA

2. GENERAL

a. The Model 179 Standard Pulse Generator is a general-purpose source of high-amplitude positive or negative pulses. Output amplitude is continuously variable over a range of approximately 0.5 volt to maximum output.

b. A monostable, adjustable-width multivibrator is triggered either by the internal, free-running frequency multivibrator or by external pulses. A limiter and driver amplifier shape the pulse delivered to the output amplifier.

3. TECHNICAL CHARACTERISTICS

a. Repetition Rate:

(1) Internal Multivibrator - 60 to 100,000 pulses per second in three continuous, calibrated ranges.

(2) External Trigger - random or continuous triggering from 0 to 200,000 pulses per second. External triggering pulse may be positive or negative polarity with a minimum peak amplitude of 5 volts.

b. Pulse Width:

(1) 0.5 to 60 microseconds up to 10% duty cycle for full rating. Continuously variable with calibrated dial.

c. Pulse Shape:

(1) Rise time - 0.1 microsecond

(2) Fall time - 0.15 microsecond

(3) Crest variation (other than overshoot) - less than $\pm$ 3%.

(4) Overshoot and undershoot - less than 6%.

d. Pulse Amplitude:

(1) Positive - Approximately 200 volts, peak, maximum.

(2) Negative - Approximately 150 volts, peak, maximum.

e. Amplitude Control:

(1) Continuously variable over 400 to 1 voltage range (52 db). Ten position voltage divider plus a variable interpolating control.

f. Output Impedance:

(1) 250-ohm amplifier driving a 1000-ohm voltage divider. Will operate directly into 50-ohm terminated cable.

g. Synchronization:

(1) SYNC OUT. - 15-volt, 0.5 microsecond positive pulse. Leads front edge of output pulse by approximately 0.03 microsecond. Output impedance approximately 5000 ohms.

(2) SYNC IN. - The frequency multivibrator may be synchronized with an external signal having a minimum peak amplitude of 2 volts.

4. COMPONENTS SUPPLIED

a. See Table I. Table of Components.

TABLE I. TABLE OF COMPONENTS

Qty.	Description	Case Dimensions			Weight
		Height	Width	Depth	
1	Model 179 Standard Pulse Generator.	10"	14"	7-1/4"	30#
1	Tube, #5U4GB, installed.				
1	Tube, #0A2, installed.				
3	Tube, #6BQ7A, installed.				
1	Tube, #6CL6, installed.				
2	Tube, #6DQ6A, installed.				
1	Diode Crystal, 1N34-A.				
1	Lamp, pilot, installed.				
1	Instruction Manual.				

5. EXPORT PACKAGING

a. When export shipment is required, the instrument is packed in a wooden box.

TABLE II. EXPORT PACKAGING DATA

No. of Packages	Case Dimensions			Weight	Cu.Ft.
	Height	Width	Depth		
1	17"	22"	17"	68#	3.7

CHAPTER 2

OPERATING INSTRUCTIONS

SECTION I.

SERVICE UPON RECEIPT OF EQUIPMENT

6. UNPACKING

a. Observe precaution when unpacking the equipment to avoid damaging or marring the surface.

(1) Place the packing case in a location where it can be easily handled.

(2) Remove nails with nail puller, if a nailed box is used, or cut seals of carton.

(3) Lift instrument from packing case and remove outer wrappings.

SECTION II.

CONTROL FUNCTIONS

7. FREQUENCY

a. The FREQUENCY dial provides continuous tuning of the frequency multivibrator over a frequency ratio of 60 to 1000. The dial is calibrated in cycles and, in conjunction with the FREQ. MULT. switch, controls the repetition rate of the output probe.

8. PULSE WIDTH

a. This control determines the width of the output pulse.

9. OUTPUT VOLTS Dial

a. This provides continuous incremental adjustment of output pulse amplitude.

10. TRIG. OR SYNC. GAIN

a. This controls the amplitude of the incoming synchronizing or triggering pulse to prevent possible overload and mal-functioning of the internal circuits.

11. FREQ. MULT.

a. This five-position switch performs a dual purpose:

(1) The three positions marked X1, X10 and X100 select range capacitors in the frequency multivibrator. The product of switch position and setting of the FREQUENCY dial indicates repetition rate of output probe.

(2) When placed in TRIG + OR - positions, the frequency multivibrator is made inoperative and the output pulse is dependent upon the polarity and repetition rate of the trigger pulse.

12. POLARITY

a. This switch selects polarity of output pulse.

13. VOLTS Switch

a. This ten-position switch provides coarse adjustment of output voltage.

14. CONNECTORS

a. TRIG OR SYNC IN. - External synchronizing or triggering voltage is applied to this connector.

b. SYNC OUT. - The synchronizing pulse from the internal multivibrator is available at t his connector.

c. DIRECT OUTPUT. - This connector is directly connected to the output attenuator and therefore, there will be a residual d-c potential present when the POLARITY switch is set for positive output. This will not be present for negative operation.

d. PULSE OUTPUT. - This connector is capacitively coupled to the output attenuator to remove the d-c component from positive pulses. Pulse shape is unaltered.

e. Unmarked ground binding posts are located at each side of the panel directly below the input and output connectors.

15. POWER

a. The power switch, pilot light and fuse are located on the bottom, center of the panel.

SECTION III.

OPERATION

16. INSTALLATION

a. The Model 179 Pulse Generator is portable equipment and requires no permanent installation. Sufficient clearance should

be provided between back of case and wall to insure free draft through ventilation ports.

17. CONNECTIONS FOR OPERATION

a. Plug line cord into 117 volts, 60 cycle power source and place POWER switch in on (up) position. Allow about 10 minutes for tube operation to become stabilized.

b. As the Model 179 may be used for a multitude of tests, external connections will depend upon the nature of the test and the data to be obtained or observed.

> NOTE: There is a d-c potential present at the DIRECT OUTPUT connector when the POLARITY switch is in + position. If this d-c component is undesirable, connect to PULSE OUTPUT connector.

c. In order to minimize rise and decay times, keep output cables as short as possible, and properly terminated. The maximum output voltage is proportional to the cable impedance. The RG-65/U cable will provide a time delay in the output pulse as referred to the synchronizing output pulse. Recommended cables are:

RG-58A/U	50 ohms impedance
RG-62/U	93 ohms impedance
RG-63/U	125 ohms impedance
RG-65/U	1000 ohms impedance (delay cable)

d. The output impedance of the Model 179 will vary depending upon setting of the output attenuator (VOLTS). This should be considered when approximating the voltage across a terminated output cable. Approximate output impedance is shown in Table 3.

TABLE III. APPROXIMATE OUTPUT IMPEDANCE - OHMS

VOLTS Switch Setting	90	80	70	60	50	40	30	20	10	0
Approximate Ohms	200	255	290	310	315	305	275	235	175	0 to 100

18. PULSE WIDTH ADJUSTMENT

a. Maximum pulse width (60 microseconds) should be used judiciously at pulse repetition rates above 1650 per second. Pulse widths greater than 10% of the duty cycle may result in degradation of rise time and decrease in output amplitude. The maximum pulse width for a 10% duty cycle is given by the formula.

$$\text{Max. Pulse Width (microseconds)} = \frac{100}{f}$$

where f = pulse rate in kilocycles per second.

TABLE IV. PULSE AMPLITUDE VS. LOAD RESISTANCE

a. OUTPUT PULSE AMPLITUDE VERSUS LOAD RESISTANCE

Load R in Ohms	Positive Pulse		Negative Pulse	
	10% duty cycle	0.5 microsecond width	10% duty cycle	0.5 microsecond width
∞	210	200	160	150
1000	185	170	120	130
500	170	150	100	120
250	120	110	70	90
200	95	90	56	80
100	55	60	35	50
50	30	32	20	26

NOTE: Output controls set for maximum voltage. In general, output voltage is within ± 10% of above values.

b. OUTPUT WAVE SHAPE AS A FUNCTION OF LOAD

In general the rise and fall times are decreased when a resistive load is connected to the output.

For very low settings of the output control and a low load resistance, the wave shape is partially differentiated. In this case, the correct wave shape may be restored by connecting a capacitor of approximately 100 micromicrofarads across the output.

CHAPTER 3

MAINTENANCE INSTRUCTIONS

SECTION I.

MAINTENANCE

19. GENERAL

a. Preventive maintenance procedures are not recommended for the Model 179. Critical adjustments may be disturbed by too frequent inspection on the part of personnel unfamiliar with its design, thus causing faulty operation that would be much more serious than an occasional operational failure.

b. If failure occurs, reference to Table IV, Trouble Localizing Chart, may indicate the cause. If trouble is of a more serious nature, the instrument should be returned to MEASUREMENTS.

c. For removal of instrument from case, see paragraph 32.

NOTE

Meter bearings should be lubricated at 2 to 6 month intervals (depending upon frequency of use). Use a drop or two of premium grade SAE 20 or 30 oil.

CHAPTER 4

EQUIPMENT USED IN CONJUNCTION WITH MODEL 179

SECTION I.

ACCESSORIES

20. RECOMMENDED ACCESSORIES

a. The following cables will provide convenient means for connecting the Model 179 to equipment with a wide range of input impedance.

Input Impedance	Cable Description
50 ohms	Cable consisting of 4-ft. length Type RG-55/U cable with UHF male connector on one end and pair of 3/4" spaced binding posts terminated by 50-ohm resistor at other end. Measurements Part No. H-6443.
73 ohms	Similar to above but uses RG-59/U cable with 73-ohm termination. Measurements Part No. H-6444.
125 ohms	Similar to above but uses RG-63/U cable with 125-ohm termination. Measurements Part No. H-6445.
1000 ohms	Similar to above but uses RG-65/U cable with 1000-ohm termination. Measurements Part No. H-6446.

21. RECOMMENDED AUXILIARY EQUIPMENT

a. An oscilloscope with a bandwidth of 20 to 30 megacycles.

CHAPTER 5

TECHNICAL SERVICE - MAINTENANCE INSTRUCTIONS

SECTION I.

GENERAL

22. SCOPE

a. The purpose of this chapter is to acquaint operating and maintenance personnel with the theory of operation of the various circuits in the Model 179 Standard Pulse Generator and to describe adjustments that may be required following tube replacement.

b. Field servicing of the Model 179 is not recommended. When service of a major nature requiring replacement of circuit components other than tubes is indicated, the instrument should be returned to MEASUREMENTS.

SECTION II.

CONDENSED THEORY OF OPERATION

23. FREQUENCY MULTIVIBRATOR

a. The frequency determining multivibrator used in the Model 179 is shown schematically in figure 2. A small voltage, say a positive potential on the grid of the A triode section of V4, is amplified by section A and B and applied back to the grid of section A to be reamplified. This action takes place almost instantly and, being repeated over and over causes the grid of section A to assume a high positive potential while the grid of section B becomes increasingly negative and soon exceeds the cutoff potential thus reducing plate current to zero. Section A now draws heavy plate current and continues to do so until the charge on capacitor C9 is discharged through grid-leak resistors R18, R19B and brings the grid potential of section B back toward zero.

b. At the instant the grid potential of section B reaches cutoff, this section can now amplify once more. Decreasing negative potential on the grid of section B is amplified and causes the grid potential of section A to become suddenly negative. This results in section B drawing high plate current while section A is cutoff.

c. The charge on capacitor C10 is now discharged through resistors R16, R19A and R20 and finally the cycle is repeated.

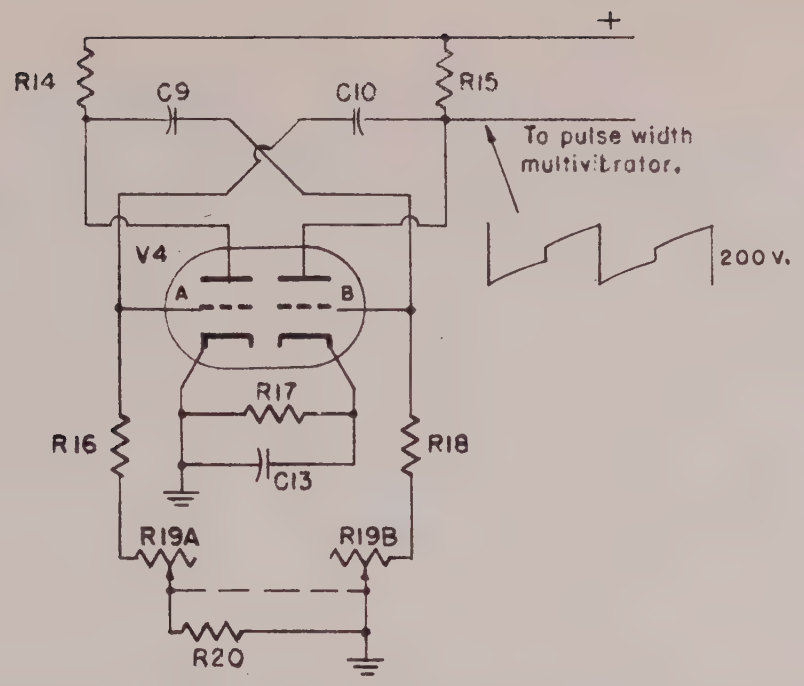


Fig. 2. Functional Schematic, Frequency Multivibrator (X1 positio

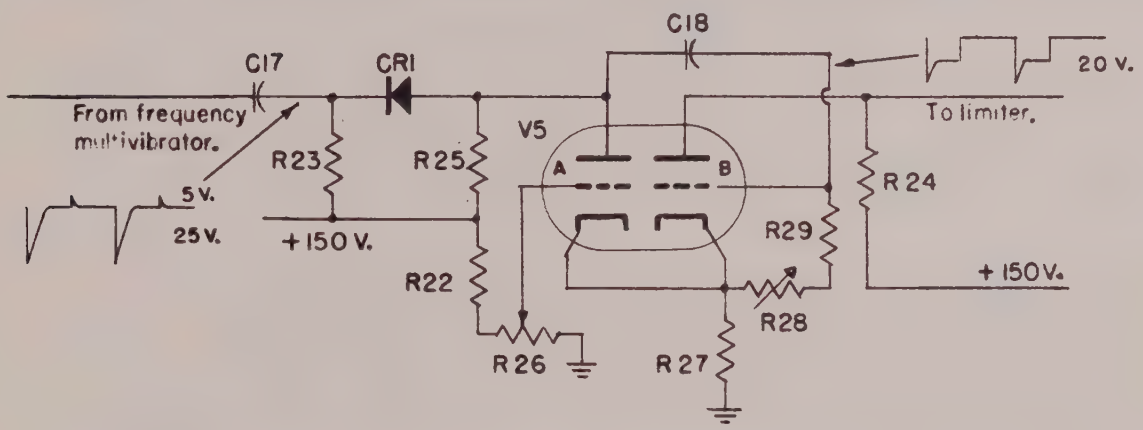


Fig. 3. Functional Schematic, Pulse Width Multivibrator.

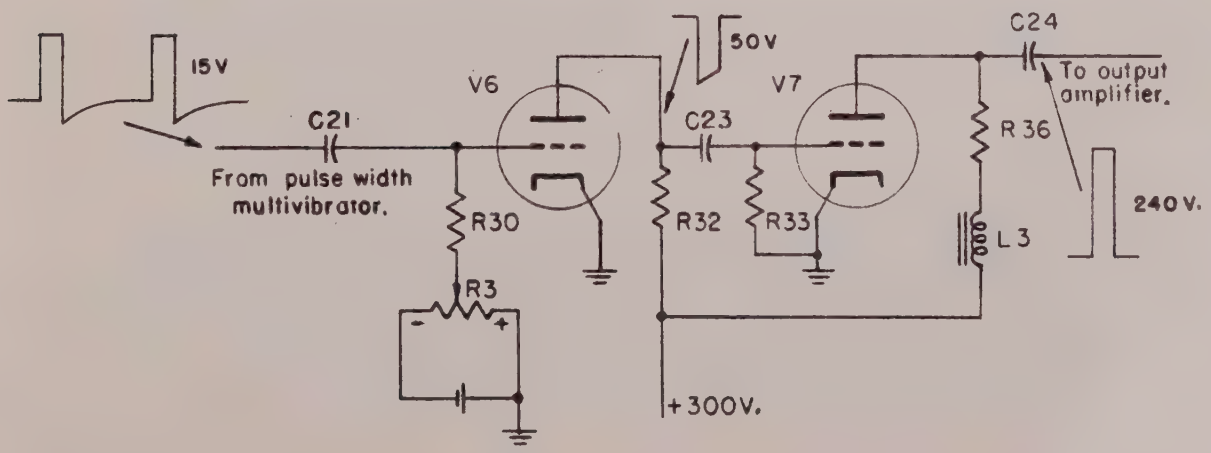


Fig. 4. Functional Schematic, Limiter/Driver Circuit.

d. The frequency of this circuit is determined by the time constants C9 (R18 + R19B) and C10 (R16 + R19A + R20).

e. The conventional biasing used in the cathode of section B (R17, C13) permits this triode to function as an amplifier when operation is to be controlled from external trigger pulses.

24. PULSE WIDTH MULTIVIBRATOR

a. The square-wave output of the frequency multivibrator is applied through a differentiating circuit to a cathode-coupled, "one-shot" multivibrator which determines the width of the output pulse. These circuits are shown in figure 3. During the quiescent period triode section B of tube V5 carries a large plate current, since its grid is at cathode potential, and raises the cathode potential of sections A and B considerably positive with respect to ground. This results in plate cut-off for section A.

b. Application of the multivibrator output wave across capacitor C17 in series with resistor R23 results in differentiated positive and negative pulses being applied across diode CR1 and resistor R25. With no signal applied, or on positive pulses, the diode CR1 is non-conductive as its cathode potential is either equal to or greater than its anode potential. However, on negative pulses the cathode is momentarily driven negative, dropping the plate voltage of section A, tube V5. This causes capacitor C18 to discharge through resistors R27, R28 and R29, thus biasing the grid of section B below cutoff to stop conduction. As a result, section A becomes conducting, causing a large potential drop across R25.

c. At the instant plate current is cut off through section B, its plate potential rises to value of the plate supply (150 volts). This voltage is applied across the limiter input as long as section B is non-conductive. However, when the charge on C18 leaks off through resistors R28 and R29 to reduce the negative potential on section B grid below cut-off, section B again conducts, section A is cut-off and the original quiescent condition is restored.

d. The time constant of C18 (R29 + R28) determines the non-conduction period for triode section B, and consequently the pulse width of the output pulse.

25. LIMITER AND DRIVER

a. Shaping and amplification of the pulse delivered by the pulse-width multivibrator is performed by tubes V6 and V7. A functional schematic of these circuits is shown in figure 4. For simplification, tubes are shown as triodes. During the quiescent period, tube V6 is biased beyond cutoff, thus its plate potential is equal to the plate supply (300V). Tube V7 is conducting and its plate potential is very low.

b. When a positive pulse is applied to the grid of tube V6, plate current will flow the instant the grid potential is reduced to cut-off and continue to increase until the grid is driven sufficiently positive to produce plate current saturation. This results in a negative voltage pulse of rectangular shape being applied to the grid circuit of tube V7.

c. The application of a high negative voltage to the grid of V7 biases tube V7 beyond cutoff and its plate potential immediately rises to maximum (300 volts). This pulse is delivered through capacitor C24 to the output amplifier.

d. Coil L3 serves as a peaking coil to improve the rise time of the output pulse.

26. OUTPUT AMPLIFIER

a. The output amplifier operates either as a cathode follower or straight amplifier, depending upon the desired polarity of the output pulse. A simplified circuit is shown in figure 5. During the quiescent period, the cathode of tube V8 assumes a positive potential with respect to the grid and reduces plate current to a low value.

b. The positive pulse delivered through capacitor C24 and resistor R41 drives the grid positive with respect to the cathode thus causing a sudden increase in plate current.

(1) When the polarity switch is in the positive position, figure 5 (a), this surge of plate current increases the potential drop across the output attenuator and a positive pulse is delivered to the output terminals. It will be noted that the pulse delivered to the DIRECT OUTPUT terminals is superimposed upon the d-c potential of the cathode. Capacitor C28 removes the d-c component from the pulse delivered to the PULSE OUTPUT terminals.

(2) When the polarity switch is in the negative position, figure 5 (b), the surge of plate current drops the plate potential of tube V8 thus delivering a negative pulse through C27 to the output attenuator. In this circuit arrangement, the d-c component is removed by capacitor C27, and the pulse from either the DIRECT OUTPUT or the PULSE OUTPUT has no d-c component.

c. Inverse feedback is applied through coupling resistor R47.

27. SYNCHRONIZING CIRCUITS

a. The frequency multivibrator of the Model 179 may be synchronized from an external source or may furnish a synchronizing pulse to associated equipment. These circuits are conventional and require no detailed explanation, see schematic diagram.

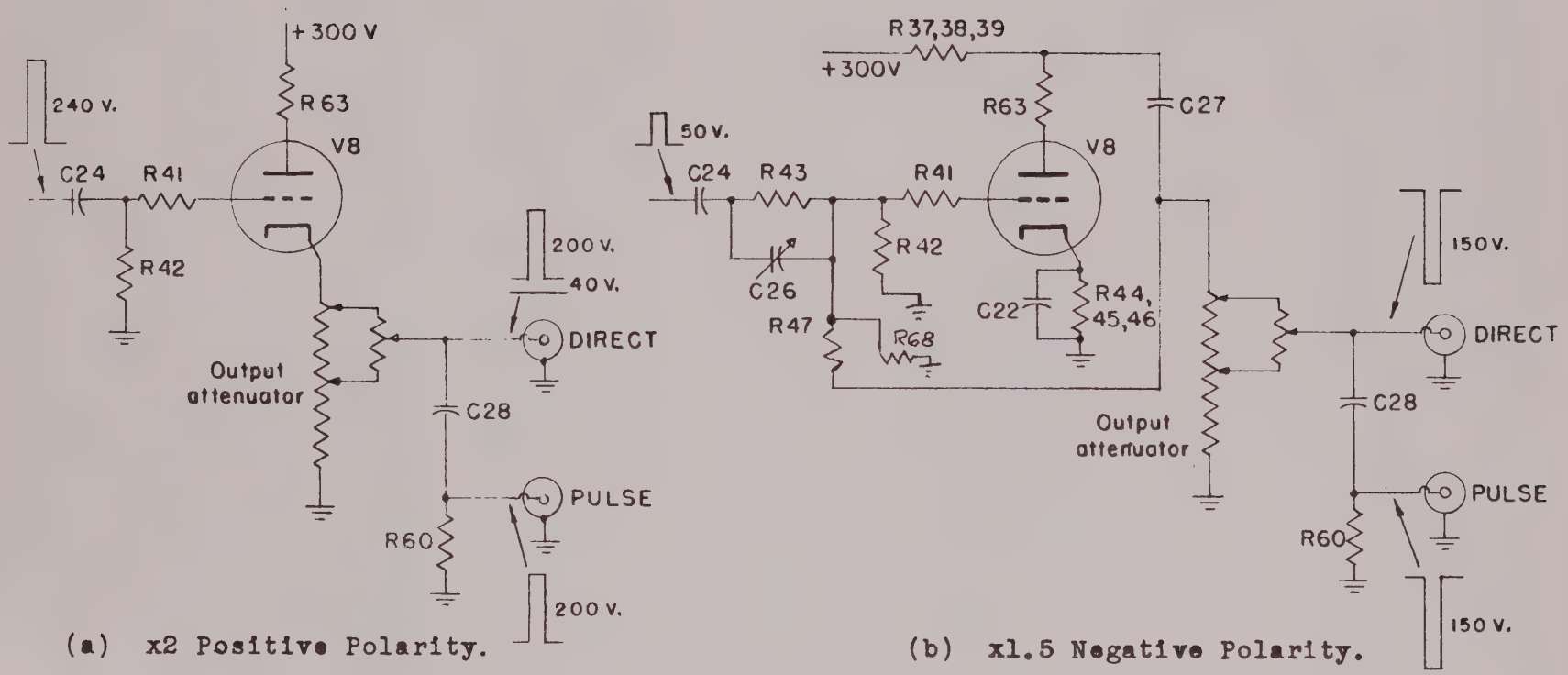


Fig. 5. Functional Schematic, Output Amplifier.

b. SYNC IN. - The incoming synchronizing pulse is applied to the grid of one section of tube V3, amplified, and then applied to the grid of one section of the frequency multivibrator. Incoming pulses may be sinusoidal, triangular, or rectangular.

c. SYNC OUT. - Pulses from the plate of the output triode of the frequency multivibrator are differentiated by C5 - R10 and are then applied to the grid of the second triode of tube V3 which operates as an isolating amplifier.

28. TRIGGER CONTROL

a. During trigger operation, the repetition rate of the output pulse is controlled by an external trigger circuit and is independent of the internal frequency-determining multivibrator, see schematic diagram.

b. When the FREQ. MULT. switch is set at + TRIG, the output pulse will be controlled by a positive pulse applied to connector, J1. One grid of the frequency multivibrator, tube V4, is grounded, thus preventing multivibrator action. The incoming pulse is applied to the grid of the second section of tube V4, amplified, and then delivered as a negative pulse to the differentiating network consisting of capacitor C17 and resistor R23.

c. When the FREQ. MULT. switch is set at - TRIG, the output pulse will be controlled by a negative pulse applied to connector J1. The negative pulse is first amplified by one triode of tube V3 which reverses its polarity to produce a positive pulse at the second grid of tube V4. Further action is as described in (b).

29. POWER SUPPLY

a. The power supply used in the Model 179 is of conventional design as can be seen by reference to the schematic. The plate voltage is obtained from a full-wave rectifier (tube V1) which is arranged to provide the negative bias required for the limiter tube, V6. Voltage regulator tube, V2, stabilizes the 150-volt potential for plates of the pulse width multivibrator and limiter/driver tubes.

b. In order to avoid excessive difference in potential between cathode and heater of tube V8, its filament is biased positive with respect to ground by the voltage divider consisting of resistors R4 and R61.

SECTION III.

TROUBLE LOCATION

30. LOCALIZING THE TROUBLE

a. Table V. lists possible trouble and cause.

TABLE V. TROUBLE LOCALIZING CHART

Trouble	Possible Cause
No Output.	Defective fuse. Inoperative tubes (V1, V4, V5, V6, V7, V8) or crystal diode, (CR1).
Low Output.	Low B+ voltage, or defective tube, V8.
Distorted output pulse.	If on + and - polarity, check R3. If on - polarity only, check C26. (see paragraph 33.)
Actual pulse width differs from calibration of PULSE WIDTH dial.	Check setting of R26.
Excessive hum in output.	Defective tube, V8.
No output SYNC pulse. Not responsive to input SYNC or TRIGGER pulses.	Defective tube, V3.
Excessive temperature rise.	Motor (B1) inoperative.

SECTION IV.

REPAIR PROCEDURES

31. GENERAL

a. When trouble occurs consult Trouble Localizing Chart, Table IV. for possible cause and remedy. If it is necessary to remove the instrument from its case, follow instructions in the following paragraph.

> NOTE: When major repairs are required, return the instrument to MEASUREMENTS, Boonton, N.J.

32. REMOVAL FROM CASE

a. Remove #10 binding head screw at upper left-hand side of panel and at upper right-hand side of panel. Remove the four screws at the bottom edge of the front panel.

b. The front panel may now be removed from the case.

c. The power circuit is attached to the rear wall of case and attached to front panel by a flexible cable. Removal of the power unit will seldom be required as all tubes are readily accessible.

33. ADJUSTMENT PROCEDURES

a. EQUIPMENT REQUIRED. - The basic equipment required for properly adjusting the shape of the output pulse is a good oscilloscope. This oscilloscope should have a band-width of at least 20 megacycles to avoid introducing distortion not present in the pulse under observation.

b. BASIC PULSE RATE AND PULSE WIDTH. - For the following adjustments use a pulse repetition rate of 1000 cycles per second and a pulse width of 10 microseconds.

c. BIAS ADJ. (R26) - Replacement of tube V5, may affect pulse width sufficiently to require resetting of this control.

(1) Connect an oscilloscope to PULSE OUTPUT connector. Keep leads as short as possible. Adjust output pulse and oscilloscope gain to produce a suitable pattern on the screen.

(2) Set PULSE WIDTH control to 60 microseconds.

(3) Adjust BIAS ADJ. (R26) to produce a pulse width of 60 microseconds.

(4) Rotate PULSE WIDTH control to maximum counter-clockwise position. Width of the observed pulse should be less than 0.5 microsecond.

d. CLIP LEVEL (R3) - Replacement of tubes V5 or V6 may require readjustment of the clipping level.

(1) Connect an oscilloscope to PULSE OUTPUT connector. Adjust its gain to avoid overloading of its input circuits.

(2) Adjust CLIP LEVEL (R3) to produce a clean, straight base line with no trailing edge overshoot. Do not overclip as this may reduce amplitude of output pulse.

e. COMP. (C26) - If the negative output pulse, when viewed on the oscilloscope screen contains pips or a decided slope to the base of its trailing edge which does not appear with positive polarity, this control should be reset.

(1) Rotate trimmer (C26) until pips are minimized and trailing edge is straightened.

f. Current limiter resistor (R5) is set at the factory and should not require readjustment. Whenever a new tube, V2, is installed, it should be checked for firing on both low and high voltage. If it fails to fire and remain ignited on low voltage, resistor R5 should be reset.

NOTE: Best regulation will be obtained when the regulator current through tube V2 does not exceed 30 milliamperes at high line voltage.

APPENDIX I

STORAGE AND SHIPMENT

1. STORAGE

a. Remove dust from controls and outer surface of instrument with a clean rag.

b. Wrap instrument in heavy wrapping paper and seal seams with gummed tape or similar adhesive.

c. Store in a dry place. If excessive humidity is unavoidable, the wrapped instrument should be placed in a moisture-proof bag with a sufficient quantity of drying agent, such as silica gel, to insure a dry atmosphere. When the use of bag and desiccant is necessary, the instrument should be checked at six-month intervals to determine the effectiveness of the seal.

2. SHIPMENT

a. Wrap the instrument with heavy wrapping paper and seal seams with gummed tape or similar adhesive.

b. Place in fibre-board carton or wooden box large enough to permit at least three inches of excelsior or similar packing material between the instrument and sides of the box. For export packing, the instrument must be wrapped in waterproof paper and the seams sealed with waterproof glue or similar sealing compound before being placed in a wooden box.

APPENDIX II.

TABLE OF REPLACEABLE PARTS

Model 179 Standard Pulse Generator

Symbol	Measurements Part No.	Description
B1	H-6387	Motor with Fan Blade.
Capacitors		
C1	H-5182	Fixed; Electro; 25 mf, 25 WVDC.
C2	H-6602	Fixed; Electro; 20-20-20-20 mf, 475 WVDC.
C3	H-5579	Fixed; Electro; 4 mf, 450 WVDC.
C4	H-5589	Fixed; Paper; .1 mf, 400 WVDC.
C5	H-5503	Fixed; Ceramic; 4.7 mmf ± 10%, NPO.
C6	H-5589	Fixed; Paper; .1 mf, 400 WVDC.
C7	H-5170	Fixed; Mica; 85 mmf, 500 WVDC.
C8	H-6388	Fixed; Mica; .001 mf, 500 WVDC.
C9	H-6389	Fixed; Mica; .01 mf ± 300 WVDC.
C10	H-6389	Fixed; Mica; .01 mf, 300 WVDC.
C11	H-6388	Fixed; Mica; .001 mf, 500 WVDC.
C12	H-5170	Fixed; Mica; 85 mmf, 500 WVDC.
C13	H-5182	Fixed; Electro; 25 mf, 25 WVDC.
C14	H-6306	Fixed; Ceramic; .02 mf, mf, GMV.
C15	H-5356	Fixed; Ceramic; .01 mf, GMV.
C16	H-5002	Fixed; Electro; 8 mf, 450 WVDC.
C17	H-6391	Fixed; Ceramic; 22 mmf ± 5%.
C18	H-5170	Fixed; Mica; 85 mmf ± 2%, 500 WVDC.

Symbol	Measurements Part No.	Description
C19	H-5182	Fixed; Electro; 25 mf, 25 WVDC.
C20	H-5500	Fixed; Ceramic; .001 mf, GMV.
C21	H-5356	Fixed; Ceramic; .01 mf, GMV.
C22	H-5003	Fixed; Electro; 20-20-20-20 mf., 450 WVDC.
C23	H-5356	Fixed; Ceramic; .01 mf, GMV.
C24	H-6390	Fixed; Plastic; .1 mf, 400 WVDC.
C25	H-5579	Fixed; Electro; 4 mf, 450 WVDC.
C26	H-6392	Variable; 2-25 mmf.
C27	H-5002	Fixed; Electro; 8 mf, 450 WVDC.
C28	H-5002	Fixed; Electro; 8 mf, 450 WVDC.
C29	H-5589	Fixed; Paper; .1 mf, 400 WVDC.
C30	H-5356	Fixed; Ceramic; .01 mf, GMV.
C31	H-5356	Fixed; Ceramic; .01 mf, GMV.
C32	H-6610	Fixed; Elec. 40 mf, 450 WVDC.
CR1		Crystal Diode, 1N34A.
F1	H-5018- 12	Fuse, 2 Amp. Amp.
I1	H-6315	Lamp, 6 - 8 V.
J1		Receptacle SO-239.
J2		Receptacle SO-239.
J3		Receptacle SO-239.
J4		Receptacle SO-239.

Symbol	Measurements Part No.	Description
L1	H-3561	Choke; 10 henries.
L2	H-3561	Choke; 10 henries.
L3	H-6259	Choke; 25 microhenries.
P1		Plug, (See W1).
Resistors		
R1	H-6395	Fixed; w.w., 50 ohms, 5 W.
R2	H-3728-683	Fixed; Comp; 68K ohms ± 5%, 1/2 W.
R3	H-5363	Variable; Comp; 100K ohms.
R4	H-3728-224	Fixed; Comp; 220K ohms, ± 10%, 1/2 W.
R5	H-6393	Adjustable; w.w., 5K ohms, 25 W.
R6	H-3728-331	Fixed; Comp; 330 ohms, ± 10%, 1/2 W.
R7	H-3728-104	Fixed; Comp; 100K ohms, ± 10%, 1/2 W.
R8	H-3728-562	Fixed; Comp; 5600 ohms, ± 5%, 1/2 W.
R9	H-3728-562	Fixed; Comp; 5600 ohms, ± 5%, ± 5%, 1/2 W.
R10	H-3728-222	Fixed; Comp; 2200 ohms, ± 10%, 1/2 W.
R11	H-3728-471	Fixed; Comp; 470 ohms, ± 5%, 1/2 W.
R12	H-3728-471	Fixed; Comp; 470 ohms, ± 5%, 1/2 W.
R13	H-6360	Variable; Comp; 50K ohms, linear taper.
R14	H-3734-153	Fixed; Comp; 15K ohms, ± 10%, 2 W.
R15	H-3734-153	Fixed; Comp; 15K ohms, ± 10%, 2 W.

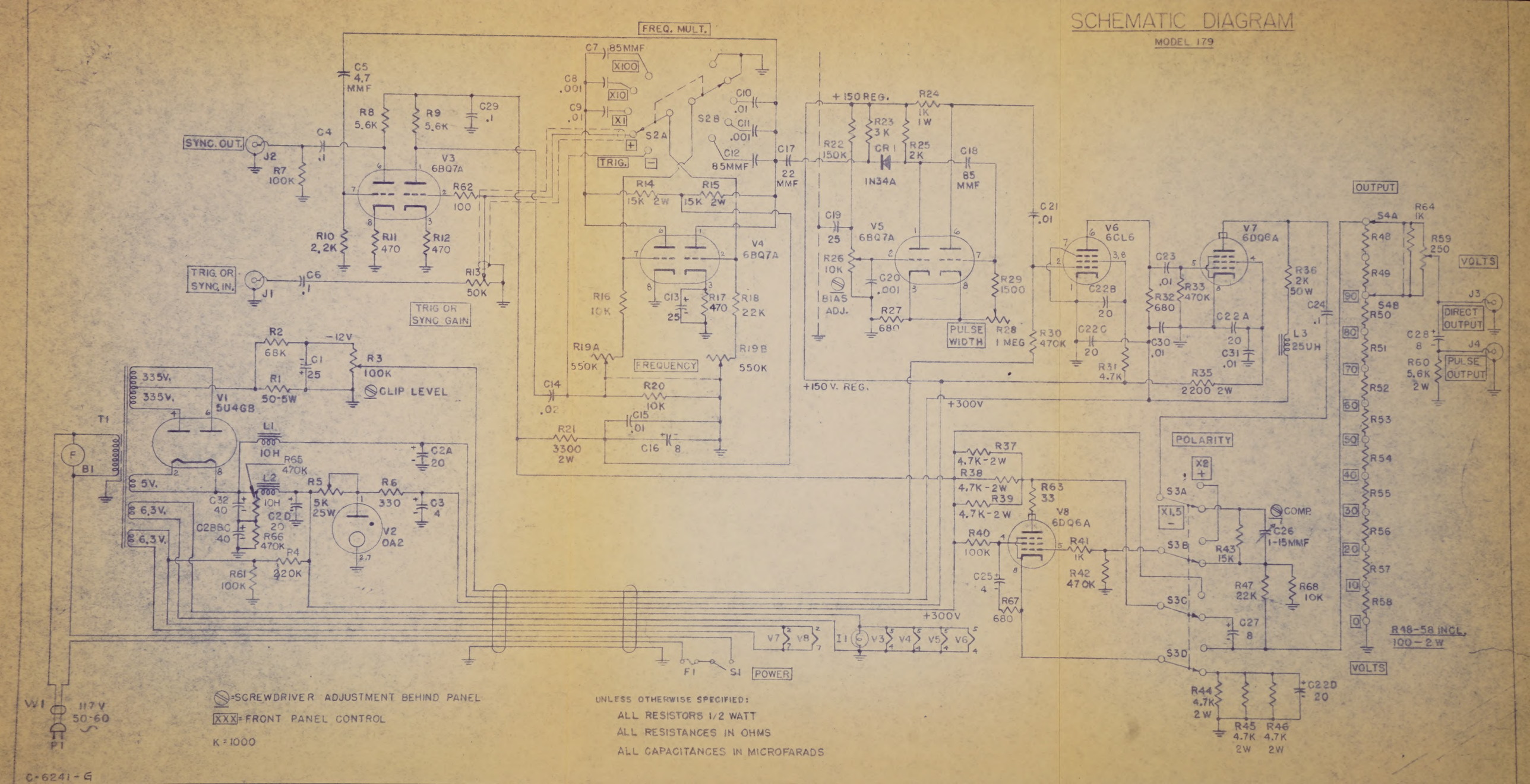
Symbol	Measurements Part No.	Description
R16	H-3728-103	Fixed; Comp; 10K ohms, ± 10%, 1/2 W.
R17	H-3728-471	Fixed; Comp; 470 ohms, ± 10%, 1/2 W.
R18	3728-223	Fixed; Comp; 22K ohms, ± 10%, 1/2 W.
R19	T1	Variable; Comp; Dual, 550K-550K ohms.
R20	H-3728-103	Fixed; Comp; 10K ohms, ± 10%, 1/2 W.
R21	H-3734-332	Fixed; Comp; 3300 ohms, ± 10%, 1/2 W.
R22	H-3728-154	Fixed; Comp; 150K ohms, ± 10%, 1/2 W.
R23	H-3727-302	Fixed; Comp; 3K ohms, ± 5%, 1/2 W.
R24	H-3731-102	Fixed; Comp; 1K ohms, ± 10%, 1 W.
R25	H-3727-202	Fixed; Comp; 2K ohms, ± 5%, 1/2 W.
R26	H-6397	Variable; w.w., 10K ohms.
R27	H-3728-681	Fixed; Comp; 680 ohms, ± 10%, 1/2 W.
R28	H-6398	Variable; Comp; 1 megohm.
R29	H-3728-152	Fixed; Comp; 1500 ohms, ± 10%, 1/2 W.
R30	H-3728-474	Fixed; Comp; 470K ohms, ± 10%, 1/2 W.
R31	H-3728-472	Fixed; Comp; 4700 ohms, ± 10%, 1/2 W.
R32	H-3728-681	Fixed; Comp; 680 ohms, ± 10%, 1/2 W.
R33	H-3728-474	Fixed; Comp; 470K ohms, ± 10%, 1/2 W.
R34		Not used.
R35	H-3734-222	Fixed; Comp; 2200 ohms, ± 10%, 2 W.

Symbol	Measurements Part No.	Description
R36	H-6394	Fixed; w.w., 2K ohms, 50 W.
R37	H-3734-472	Fixed; Comp; 4700 ohms, ± 10%, 2 W.
R38	H-3734-472	Fixed; Comp; 4700 ohms, ± 10%, 2 W.
R39	H-3734-472	Fixed; Comp; 4700 ohms, ± 10%, 2 W.
R40	H-3728-104	Fixed; Comp; 100K ohms, ± 10%, 1/2W.
R41	H-3728- 102	Fixed; Comp; 1K ohms, ± 10%, 1/2 W.
R42	H-3728-474	Fixed; Comp; 470K ohms, ± 10%, 1/2 W.
R43	H-3728-153	Fixed; Comp; 15K ohms, ± 10%, 1/2 W.
R44	H-3734-472	Fixed; Comp; 4700 ohms, ± 10%, 2 W.
R45	H-3734-472	Fixed; Comp; 4700 ohms, ± 10%, 2 W.
R46	H-3734-472	Fixed; Comp; 4700 ohms, ± 10%, 2 W.
R47	H-3728-223	Fixed; Comp; 22K ohms, ± 10%, 1/2 W.
R48	H-3734-101	Fixed; Comp; 100 ohms, ± 10%, 2 W.
R49	H-3734-101	Fixed; Comp; 100 ohms, ± 10%, 2 W.
R50	H-3734-101	Fixed; Comp; 100 ohms, ± 10%, 2 W.
R51	H-3734-101	Fixed; Comp; 100 ohms, ± 10%, 2 W.
R52	H-3734-101	Fixed; Comp; 100 ohms, ± 10%, 2 W.
R53	H-3734-101	Fixed; Comp; 100 ohms, ± 10%, 2 W.
R54	H-3734-101	Fixed; Comp; 100 ohms, ± 10%, 2 W.
R55	H-3734-101	Fixed; Comp; 100 ohms, ± 10%, 2 W.
R56	H-3734-101	Fixed; Comp; 100 ohms, ± 10%, 2 W.
R57	H-3734-101	Fixed; Comp; 100 ohms, ± 10%, 2 W.
R58	H-3734-101	Fixed; Comp; 100 ohms, ± 10%, 2 W.

Symbol	Measurements Part No.	Description
R59	H-6396	Variable; Comp; 250 ohms.
R60	H-3734-562	Fixed; Comp; 5600 ohms, ± 5%, 2 W.
R61	H-3728-104	Fixed; Comp; 100K ohms, ± 10%, 1/2 W.
R62	H-3728-101	Fixed; Comp; 100 ohms, ± 10%, 1/2 W.
R63	H-3728-330	Fixed; Comp; 33 ohms, ± 10%, 1/2 W.
R64	H-3728-102	Fixed; Comp; 1000 ohms, ± 10%, 1/2 W.
R65	H-3728-474	Fixed; Comp; 470K ohms, ± 10%, 1/2 W.
R66	H-3728-474	Fixed; Comp; 470K ohms, ± 10%, 1/2 W.
R67	H-3728-681	Fixed; Comp; 680 ohms, ± 10%, 1/2 W.
R68	H-3728-103	Fixed; Comp; 10K ohms, ± 10%, 1/2 W.
S1	H-383-5	Switch, Toggle, SPST.
S2	H-6256	Switch, Rotary.
S3	H-6255	Switch, Rotary.
S4	H-6258	Switch, Rotary.
T1	H-6273	Transformer, Power
V1		Electron Tube; 5U4GB.
V2		Electron Tube; 0A2.
V3		Electron Tube; 6BQ7A.
V4		Electron Tube; 6BQ7A.
V5		Electron Tube; 6BQ7A.
V6		Electron Tube; 6CL6.
V7		Electron Tube; 6DQ6A.
V8		Electron Tube; 6DQ6A.
W1	H-704	Cord, Power (includes P1).

SCHEMATIC DIAGRAM

MODEL 179



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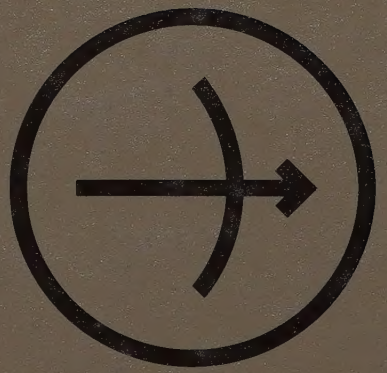
MEASUREMENTS

BOX 180, BOONTON
NEW JERSEY



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